THE AMERICAN JOURNAL
OF
OPHTHALMOLOGY.

VOL. XXII. OCTOBER, 1905. No. 10.

ORIGINAL ARTICLES.

THE MAMMALIAN EYE, WITH SPECIAL REFERENCE TO THE FUNDUS APPEARANCES.*

By CASEY WOOD, M.D., D.C.L.
CHICAGO.

ALTHOUGH we have had isolated reports of the ophthalmoscopic findings in the eyes of a few domestic animals and of some others easily accessible to man, no comprehensive study of the ocular fundi of the lower animals was made until Geo. Lindsay Johnson, with the assistance of an unusually competent artist (Arthur W. Head), began his investigations over ten years ago. Their first contribution appeared in the *Proceedings of the Zoological Society of London* in January, 1897: "Observations on the Ophthalmoscopic Appearances of the Eyes of the Order Primates," illustrated by four colored plates. In May, 1900, Dr. Johnson communicated to the London Royal Society, "Contributions to the Comparative Anatomy of the Mammalian Eye, Chiefly Based on Ophthalmoscopic Examination." This essay was published in the *Philosophical Transactions*, 194, 1901, pp. 1–82, and reprinted in the form of a descriptive atlas containing about fifty large colored engravings of various animal

*Read at the 10th annual meeting of the American Academy of Ophthalmology and Oto-Laryngology, Buffalo, Sept. 14th to 16th, 1905.

fundi from original paintings by Arthur W. Head. This work gave merely the conclusions of the writer, it being his purpose to publish in due time a still larger volume in which the ocular backgrounds of many additional mammals are to be pictured, together with those of representative amphibia and reptiles—the whole to be accompanied by a more complete treatise on the visual apparatus of these zoological subkingdoms.

Shortly after the appearance of Dr. Johnson's larger work I had the pleasure of presenting to the New Orleans meeting of the Ophthalmic Section, in a very incomplete fashion and poorly illustrated with ordinary black and white stereopticon slides, a few of the conclusions reached by the author. I refrained from printing these desultory remarks, partly because of their fragmentary character and partly because I understood that Dr. Johnson was then about to publish his larger atlas in which every zoologist and ophthalmologist might read a full account of this truly marvelous undertaking. Since this volume has, so far, not appeared and as Dr. Johnson's studies have excited comparatively little comment in ophthalmic circles, I again take the liberty, with the permission of the author and the aid of Mr. Head's reproductions in color of his original drawings, to give you some idea of the remarkable work that has been carried on by these two men. Another reason for this demonstration is that the monograph and atlas just referred to is out of print and practically unobtainable.

At the outset let us refresh our memories by looking at the following (Gadow's) classification of the mammals. Observations of the fundus oculi were made by Johnson in 182 species of Mammalia, comprising nine out of eleven Natural Orders, 103 Genera and 47 Families—the Whale and Sirenia being omitted. All the backgrounds were carefully painted, *ad naturam*, by Mr. Head. In these tables, taken from Dr. Johnson's treatise, I have, as far as possible, and for the sake of simplicity, indicated the species by their vulgar instead of their zoological names. In the list you will find italicized the names of those animals whose fundus pictures I hope to show you on the screen.

Natural Orders.	Families.	Genera.	Species and Varieties.
Primates.	Simiae.	Anthropoidae.	*Man. Chimpanzee.* Gorilla. *White-Handed Gibbon.* Ourang.
		Cercopithecidae.	Pigtailed Macaque. Japanese Ape. Bonnet Monkey. Chacma Baboon. *Mandril.* Yellow Baboon. Syke's Monkey. *Green Monkey. Black Ape. White Collared Mangabey. Sooty Mangabey. Diana Monkey.*
		Hapalidae.	The Marmosets. Squirrel Monkey.
		Cebidae.	Red Howler. Lagothrix. Nyctipitheci. *Lemurine Douroucouli.* Spider Monkey.
	Lemures.	Chiromyidae.	Aye-Aye.
		Lemurides.	*Crowned Lemur.* Brown Macaque. Black and Variegated Lemur.
		Galagoidae.	*Lemur Coquereli.* Nycticebus Tardigradus. Loris. Galago garnetti. Maholi. *Galago Monterii.*
Chiroptera.			English Bat. Indian Fruit Bat. *Australian Fruit Bat.*
Insectivora.			*Hedgehog.* Common Mole.

Natural Orders.	Families.	Genera.	Species and Varieties.
Carnivora.	Pinnipedia.		Sea Lion. British Seal.
	Fissipedia.	Felidae.	Common Cat (many varieties). *Serval.* Tiger Cat. Siamese Cat. Cheetah. Puma. African Lion. Kaffir Cat. Ocelot.
		Viverridae.	Mongoose. Spotted Ichneumon. Genetta. *Levaillant's Cynictis.*
		Mustelidae.	*Canadian Skunk.* European Polecat. Cape Zorilla. Otter. Tayra. Sand Badger. Cape Badger. Pine Marten.
		Hyenidae.	Spotted Hyena. Brown Hyena. *Striped Hyena.*
		Canidae.	Domestic Dog of many varieties. Indian Wolf. Prairie Wolf. *Black-backed Jackal.* Common Jackal. Common Fox. Azara's Fox. Fennec Fox. Arctic Fox. Cape Hunting Dog. Australian Dingo.
		Procyonidae.	*American Racoon.* Bassaricyon. Kinkajou. Ringtailed Coati.
		Ursidae.	Syrian, Brown, Malay and Sloth Bears. *Black Bear.*

Natural Orders.	Families.	Genera.	Species and Varieties.
Ungulata.	Artiodactyla.	Selenodonta. (Ruminantia).	*Indian Ox.* Many varieties of the Common Ox, Sheep, Goat and Deer. Reindeer. Gazelle, *Bactrian Camel.* Llama. Chevrotain.
		Bunodonta.	Wild and Domestic Boar. Hippopotamus.
	Perissodactyla.	Equidae.	Horse (many varieties). *Zebra.* Wild Ass.
		Tapiridae.	*American Tapir.*
		Rhinocerotidae.	*Indian Rhinoceros.*
	Proboscidae.	Elephantidae.	Indian Elephant. *African Elephant.*
	Hyracoidae.		*Dorsal Hyrax.*
Sirenia.			Porpoise.
Rodentia.	Myomorpha.	Dipodidae.	Jerboa, Egyptian and Indian.
		Geomyidiae.	Cape and American Pouched Rat.
		Muridae.	*Black Rat.* Common Rat (varieties). Mouse (varieties).
		Myoxidae.	Oak Dormouse. Garden Dormouse.
	Sciuromorpha	Sciuridae.	Common Squirrel (varieties). Marmot. Ground Squirrel. *Red and White Flying Squirrel.*
		Pteromyidae.	Indian Palm Squirrel.
		Castoridae.	*Canadian Beaver.*

Natural Orders.	Families.	Genera.	Species and Varieties.
	Hystricomorpha.	Chinchillidae.	Chinchilla. Viscacha.
		Cavidae.	*Guinea Pig*. Capybara. Spotted Cavy.
		Octodontidae.	Myopatamus Coypa.
		Dasyproctidae.	Golden Agonti. Azara's Agonti.
		Hystricidae.	*Brazilian Porcupine*. Hairy Porcupine.
	Lagomorpha.	Leporidae.	*Common Rabbit* (varieties). Hare.
Edentata.		Dasypodidae.	*Hairy Armadillo*.
		Myrmecophagidae.	Great Anteater.
		Bradypodidae.	Three-toed Sloth.
Marsupialia.	Diprotodontia.	Phascolomyidae.	Wombat.
		Macropodidae.	Tree Bangaroo. Black-faced Kangaroo. Red Kangaroo. Wallaby. *Rat Kangaroo*.
		Phalangistidae.	Black Phalanger. Squirrel Phalanger. Flying Phalanger.
	Polyprotodontia.	Didelphidae.	*Virginian Opossum*.
		Dasyuridae.	Tasmanian Devil.
		Peramelidae.	Bandicoot. *Rabbit-eared Perameles*.
Monotremata.		Echnida.	Two varieties of *Echnida*.

It may not be out of place here to refer to the methods employed by Johnson and Head in the examination and painting of the fundi of the lower animals. When one knows that this comparatively small section of the work was done on the living eyes of such animals as the lion, tiger, rhinoceros, bear, ourang, camel, tiger cat, zebra, wild ass, kangaroo, polecat, etc., one cannot but admire the bravery, patience and devotion to science for its own sake that have characterized their unique investigations. For example, as I listened to Mr. Head's account of his adventures while examining the ocular fundi of the largest *cobra di capello*, python and crocodile in the London "Zoo," it was borne in upon me that no soldier on the battlefield of science had exposed himself to greater dangers. I would advise those of you who are interested in this particular part af the investigation to read *Pearson's Magazine* for 1903, in which are reported at length some of Mr. Head's experiences while painting these wild animal fundi.

The erect image is the one portrayed in each instance, and the ordinary ophthalmoscope with a kerosene light or a common electric lamp was employed. I had the satisfaction some time ago of sending the investigators an American model of the self-illuminating electric ophthalmoscope, with which, as was self-evident, more effective work can be done in certain cases.

Both eyes were examined, the eyelids being held apart with the fingers or spring specula. In most cases mydriatics — homatropine, scopolamin or cocaine — were employed. General anæsthetics were given at first, but these were found undesirable. Some animals were muzzled or covered with a net, but, as a rule, coaxing, kindness and taming proved more effective. Wherever it was possible, several of the same species were examined so that errors due to diseases or to individual variations might be eliminated. The refraction was determined by skiascopy, and in most cases with and without atropine. The angle of optic divergence was measured by a specially devised goniometer.

Probably the most striking feature of the ocular fundi is the variety and intensity of the coloration. Ophthalmoscopists very justly claim that the background of the human

eye forms a most beautiful colored picture, but it is faded and colorless when compared with that of many an animal lower down in the zoological scale. Indeed, one of my purposes in presenting these pictures to-day, is to introduce a method of reproducing by means of stereopticon slides the brilliant coloring of the animal fundus recently invented by Mr. Head. Recognizing the failure of the ordinary colored slide to accomplish this result, he set to work some time ago to devise a means by which the wonderful coloration of these eyes could be adequately projected upon the screen. The pictures to be shown you to-day are the first slides of this kind that Mr. Head has prepared. I may also say that while the majority of the pictures appear in Johnson's Atlas, quite a few were prepared from drawings that are not reproduced there.

Dr. Johnson has divided the Mammalian fundi, so far as their color is concerned, into three categories: First, the RED TYPE, including every shade of red, brown, chocolate and gray. To this class, for example, Man and all the Primates belong. The YELLOW TYPE includes all shades of yellow and orange. Good examples of this class are found in those animals who have nocturnal habits. The GREEN AND YELLOW-GREEN TYPE comprise, among others, most of the Carnivora and many of the Ruminants. The color of the fundus in many animals is determined or modified by the thickened choroidal, or at least subretinal, layers known as the *tapetum lucidum*, *cellulosum* (in the Carnivora) or *fibrosum* (Ungulata). As is well known, in the nocturnal carnivora it glows and reflects a yellow-green light from its highly pigmented surface.

As will be noticed, many of the normal conditions observed in some of the lower animals resemble those one finds in man as pathological states, as congenital defects or as evolutionary remains. It will be sufficient now to mention the *membrana nictitans*, the retractor muscle of the globe, opaque nerve fibres, white or gray optic nerve-heads, pectinal remains, persistent hyaloid artery, optic coloboma, *retinitis pigmentosa* and visible choroidal vessels.

REFRACTION. The *wild* Mammals are simply hypermetropic; when domesticated for a number of generations they

generally become myopic and astigmatic. Fresh water amphibious Mammals have enormously developed ciliary muscles that enable them to compensate for loss of the refractive power of the cornea when the eye is submerged. The Common Seal and the Sea Lion both have a myopic refraction of 4 D. in the vertical meridian and 13 D. in the horizontal meridian. Their pupils are capable of contraction to a narrow vertical slit, so that they obtain fairly good vision both in air and water. Matthiesen, who examined a number of Whales common to the Arctic coast of Norway, found their eyes astigmatic four or five diopters.

The appearances of the fundus oculi have a decided bearing on *classification*, as will be readily seen even in this imperfect demonstration of Johnson's work. Although, as he points out, a sound classification cannot and ought not to be based upon the peculiarities of a single organ, yet the fundus appearances are so definite and so constant in all the wild species that these can be readily grouped into genera, families and natural orders according to their ophthalmoscopic pictures, a fact that must surely appeal to every zoologist. As it happens, these fundus pictures correspond very closely to the generally received classification, although there are a few disagreements, one or two of which I hope to indicate.

Although Man and the other Simiae alone possess a distinct and well defined *fovea centralis* or macular region, many other animals, the Ruminants and Carnivora for example, have a *sensitive visual area*, devoid of blood vessels, that probably acts as an extensive, although not particularly specialized macula. On the other hand, there is nothing about the background of many animals to indicate that one locality of the retina is more sensitive to light and form than any other.

The divergence of the optic axes. Johnson measured this by a special goniometer in many instances. The diagram shows that it is only the Simiae—in other words man and the true monkeys—that possess the power of convergence, and that only they have parallel vision when the eyes are in a state of rest. Parallel vision is associated, as will soon be noticed in the pictures I am about to show you, with a circular disc, well defined retinal vessels and, above all, with a well defined macula. I daresay the association might

be carried further by including binocular vision and extensive crossing of the optic fibres at a well developed chiasma.

Man.

Primates, Simiae, Anthropoidae, Man. The first variety of this species is represented in our pictures by the left fundus of a Nubian, aged 17. You will, I think, recognize a striking resemblance between it and that of the anthropoid apes. The background is chocolate colored and the retinal reflexes are very marked, extending over the whole macular region. Translucent nerve fibres can be traced much beyond the papilla. The macula is well defined and surrounded by a brilliant reflex-ring. The choroidal vessels, in contrast to those of the average European eye, are quite invisible.

In striking contrast with this picture is the fundus of a human *albino*, well known to all of you. I call especial attention to the differences in these fundi because each detail has its analogue in the lower animal backgrounds I am about to show you. As in fair-haired Europeans, the general color of the fundus is a light orange red; there is a complete absence of the peculiar glistening sheen observed in the neighborhood of the vessels and macula of the negro, and no traces of opaque nerve fibres can be discovered. The choroidal vessels are readily seen through the imperfectly pigmented background; in some albinos they are visible near the macula.

Anthropoid Apes.

Chimpanzee (Troglodes niger). The resemblance between the ocular fundus of this animal and that of the African youth just exhibited is very striking. Except that the differences between the veins and arteries are less marked and that their branches are straighter in the anthropoid ape, they are practically the same picture.

White-handed Gibbon (Hylobates albimanus). Here the nerve fibre layer and reflexes are prominent, the macular area is small, while, most noticeable of all, well marked choroidal vessels radiate from the disc to the periphery of the background.

With the exception of the color of the fundus, the ophthalmoscopic characters of man are common to all the higher monkeys.

Dog-faced Baboons.

Primates, Simiae, Cercopithecidae. The Dog-faced Baboons have a fundus more or less patterned after the Gibbon. The *Mandrill* (Cynocephalus mormon), however, exhibits the choroidal vessels more marked than in the Baboon. This ugly looking monkey possesses a power of sustained convergence equal to any of the man-like apes.

This picture does not appear in Johnson's Atlas, but is reproduced from an original drawing by Head, not yet published.

A common example of the medium sized Simian is that active and quarrelsome animal, the *Green Monkey* (Ceropithecus callitrichus). Its fundus resembles that of the Mandrill, but it has one peculiarity—a macular region twice the diameter of any other Old World monkey.

This painting does not appear in Johnson's Atlas.

Two Mangabeys, those lively, good natured and rather common monkeys, often encountered as pets, are represented in this demonstration, neither of the paintings being reproduced in Johnson's Atlas. The *White-collared Mangabey* (Cerocebus collaris) has a fundus like that of the White-handed Gibboon, except that them acular region is a dark brown spot with a well marked foveal reflex in the smaller monkey.

The *Sooty Mangabey* (Cerocebus fuliginosus) exhibits the same piculiarity, a better defined macula surrounded by a complete ring. The choroidal vessels are somewhat plainer than in the majority of the smaller monkeys.

The fundus of the *Black Ape* (Cynopithecus niger), an African monkey belonging to the same genus as the Mangabey, exhibits a well marked macular ring, probably due to the dark color of the animal itself. The background is gray and the vessel-reflexes show very plainly. His convergence power is excellent.

This is also an unpublished original painting by Head.

The *Diana Monkey* (Cercopithecus diana) is a handsome and easily tamed animal, often kept as a pet. Owing to his dark fur and the amount of pigment in his body he has, like the Black Ape, a dark gray fundus and obscure choroidal vessels. Otherwise his fundus resembles that of the other

medium sized monkeys.

This picture does not appear in the Johnson Atlas.

Primates, Simiae, Cebidae, Lemurine Douroucoli (Nyctipithecus lemurinus). The fundus of this South American monkey shows a macula well defined, but the macular ring has disappeared. To a considerable extent it resembles the true Lemurs, although its eyes show certain peculiarities. The whole background is covered with dots and resembles the lower lemurs closely, except that the disc is pink, like that of man and the higher apes, and there is a well defined macula. The choroidal vessels are well shown, but not so well as in the White-handed Gibbon.

All the Simiae invariably have circular pupils that dilate to mydriates and contract to miotics; in that respect Man differs only in degree from the other Simians. They are also the only Mammals that have parallel visual axes and possess the power of convergence, the necessary accompaniment of a macula. It must be remembered that most monkeys are able to converge for a short period only. Johnson notices a peculiar fact, that while the refraction of the higher monkeys, like savage Man, is hyperopia without much astigmatism, the Mandrills and Drills are all myopic from 3 to 6 D. As in Man, the *membrana nictitans* is rudimentary. Man alone sheds tears; the lachrymal puncta and canaliculi are rudimentary in all other Simiae, although the caruncle is present.

The Lemurs or Half-Monkeys.

Primates, Lemures, Lemuridae, Crowned Lemur (Lemur coronatus). Here is a well marked fundus. As in all animals below the true monkeys (Simiae), there is in this background no macula. The disc is chalk colored, as if the animal were the subject of a white optic atrophy. The vessels, however, are well shown and their absence in a particular area probably indicates the location of the sensitive macula.

Primates, Lemures, Galagoidae, Lemur coquereli. Although all the classifications include this animal and the next one whose fundus I shall show you, among the true Lemurs it is evident that ophthalmoscopically there is little in common between them and the Lemuridae. Indeed it is more than likely that these Galagoidae are not Lemures at all, but are more closely allied to the night-prowling carnivora,

whose fundi, as we shall see, they closely resemble. As early as 1897 Lindsay Johnson drew the attention of zoologists to this fact in a paper before the London Zoological Society. He said: "When we come to the Lemures we do not find a single animal which possesses even a trace of a macula, and the discs are all round. Instead of being pink they are quite white and the fundus is of a peculiar brown or grayish brown color stippled at intervals with large dots. In the true Galagos the disc is nearly black; the fundus is a rich golden-yellow with a tinge of green and covered everywhere with minute black or brown stellate spots. The star-shaped dots are peculiar to the Galagos and we find them in all, just as we see a distinct family likeness in the Lemures. Among the latter, however, there is one exception, its fundus being identical with that of the Galagos and yet is known as Coquerel's Lemur. I have examined this animal most carefully and am convinced that it is a Galago and not a Lemur. The difference of its eye is too striking to be overlooked and quite outweighs the other differences of structure and habitat."

Looking once more at the canvas we see at once that the animal possesses a *tapetum lucidum et nigrum*, so well shown in the Felidae, and betraying his nocturnal habits. The fundus looks as if it were made of burnished gold strewn with stars. The disc is dark gray and the periphery is covered with a dense network of pigments.

Galago Monterii. It will be seen at once that the description just given of Coquerel's Lemur applies exactly to this fundus picture, and one can readily believe that they both belong the same genus. Johnson remarks that the division between the higher and lower orders of monkeys is chiefly marked by the absence of a macula in the latter. The pupil is no longer circular but oval vertically, while the visual axesare not parallel but slightly divergent and are inof even momentary convergence. Moreover, the disc capable is no longer pink but is covered more or less with black pigment. The Simiae alone among Mammals rotate their eyes in fixation; the lower families, instead, move their heads, and only on rare occasions and to a limited extent do they move their eyes for visual purposes.

The Bats.

Chiroptera. The fundus oculi of the *Australian Fruit Bat* (Pteropus policephalus) is like that of all bats. It exhibits a picture entirely unlike any that we have so far seen and certainly indicates a lower position in the animal world than zoologists have generally assigned to its owner. The ordinary bats have such minute eyes and pupils that it is extremely difficult to paint them.

The entire background of the Australian Bat is of a uniform pinkish color, covered uniformly with large, round dots which when seen with the ophthalmoscope might easily be mistaken for pits. The papilla is grayish-white and nearly round. There are no visible vessels except a single, minute capillary in the center of the disc. The picture is certainly that of a primitive type. Johnson says that this bat's large, round pupils act sluggishly to light and mydriatics and that continued exposure to bright light produces blindness.

Insect-Eating Animals.

Speaking of the Insectivora in general Lindsay Johnson notes that the background is a uniform light gray, their eyes are equally round and small; the cornea is conical, the lids resemble a buttonhole and are destitute of lashes. The eyeball of the Mole can be projected forward several times its own diameter beyond the orbit and retracted in like manner. This is necessary for vision, as the animal's dense fur entirely covers the eye and it is needful that the eye be pushed forward between the hairs and so make a gap through which he can see.

Insectivora, Common Hedgehog (Erinaceus europaeus). Here we have a fundus of a somewhat higher type than that seen in the previous animal. The disc is small, pink and circular and exhibits two distinct sets of blood vessels. From the center there radiate to the periphery five vessels of unequal caliber, four of them giving off each a small branch on its way. From the edge of the disc spring a large number of capillaries which are soon lost to view. The veins cannot be distinguished from the arteries and there are no visible choroidal capillaries.

The Seals.

Carnivora, Pinnipedia, Common Seal (Phoca vitulina). This fundus, like that of all the Carnivora, is brilliantly colored, in this instance bright yellow, sprinkled with green dots. The disc is pale, brownish red and bordered with green. Twelve vessels arise from the papillary border, curl curl over it and are distributed to the periphery of the field. The veins cannot be distinguished from the arteries. (Fig. 1)

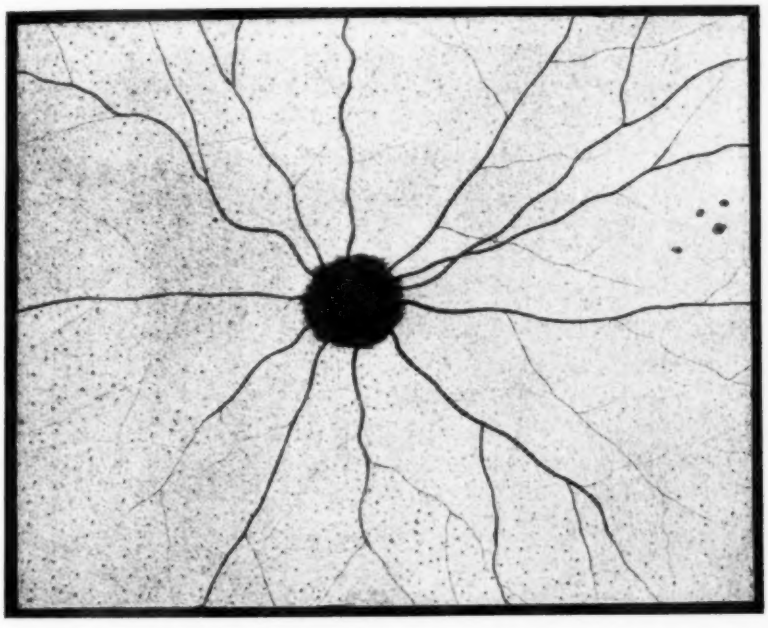

Fig. 1. Fundus of the Common Seal. [Lindsay Johnson Atlas.]

Beasts of Prey.

Carnivora, Fissipedia, Felidae. The *Serval* or *Tiger Cat* (Felis serval). This fundus is a good example of that seen in all the cat tribe. Generally there are three distinct, colored zones, the central one occupying about one-third of the whole field. It is light-gold in color, extremely brilliant, and represents the area of best vision. It is also from this portion of the background that the prowling carnivore flashes into the darkness those rays of light that have so long distinguished his yellow-green eyes. This important zone is surrounded by an emerald-green layer of variable

width, while the most peripheral zone is of a dense purple-brown color, probably a part of the ora serrata and insensitive to light. In all the Carnivora the disc is round and cupped, in some instances reminding one of a glaucomatous excavation. The pupils are generally round, although there are many exceptions to this rule. However, the pupils of the cat family are round when fully dilated, contracting to a vertically oval slit or to a straight line in all the small animals, but in the larger animals—the tiger, lion, puma, etc.—they remain round as in man. The Felidae possess no power of convergence and do not move their eyeballs for visual purposes unless trained to do so. It must be remembered, in passing, that domestication and artificial selection *affect the color of the ocular fundus and the refraction of the animal* to a considerable degree. The refraction of domestic animals (cat, dog, horse) is not the same as that of the corresponding wild species—the tendency being always in the direction of myopia and astigmatism. All the Carnivora have a movable membrana nictitans, although few of them move it freely.

Carnivora, Fissipedia, Viverridae, Levaillant's Cynictis (Cynictis penicillata). The peculiarity of this carnivore—a curious little South African animal something like our Prairie Dog—is that it has no pigmented zones in its fundus, but presents a uniform dark gray or lead color. The vessels that radiate from the disc are readily distinguished as veins and arteries; the papilla is horizontally oval and covered with a network of dark pigment. From it regular, linear, opaque nerve fibres radiate almost to the pheriphery. Altogether, this animal, as well as his brethren, the Mongoose and Ichneumon, has an ocular background quite unlike the other Fissipedia.

The Martens.

Carnivora, Fissipedia, Mustelidae, Common Skunk (Mephitis mephitica). All the Marten families (Mustelidae) have round discs; in some it is cup-shaped and the vessels, as in the Felidae, curl over it. The North American Skunk forms an exception to the usual rule of the Carnivora, in that the disc is white and cupped, with six vessels arisingfrom its margin and opaque nerve fibres radiating from its substance.

The fundus is of a pale, canary-yellow color, changing to a mottled drab near the lower edge of the disc. The *tapetum lucidum* is not as well developed as in the other carnivores. In many respectst his animal resembles the rodents; the eyes protrude, there is no membrana nictitans and the refraction is high hyperopia (5 D.).

The Hyenas.

Carnivora, Fissipedia, Hyenidae. All the Hyenas resemble the Cats in retinal blood supply and in fundus coloration. There are three zones — the central, golden yellow; the intermediate, green; the peripheral, violet. In the background of the *Striped Hyena* (Hyena striata) the disc is brown and not cupped, and the whole field is covered with minute dots, as in the Felidae. The pupil of this species is vertically oval when the animal is at rest, but when disturbed it immediately contracts to a complete circle. This and the further fact of the brilliant central zone in the fundus go along with the nocturnal habits of the animal.

The Dogs.

Carnivora, Fissipedia, Canidae. The beautiful fundi of all the Wild Dogs resemble those of the Cats and Hyenas in exhibiting three highly colored zones—an outside one reddish or violet-brown, an intermediate green area and a central zone (*tapetum ludicum*)—characteristic of higher animals—of a bright golden-yellow. The papilla is not excavated and varies in shape and size. The vessel distribution also varies; as a rule both veins and arteries tend upwards before they spread out over the fundus. All the Wolves have round pupils; all the Foxes have oval pupils. From this circumstance alone, Johnson believes that our domestic Dog is derived from the Wolf and Jackal, and not, as some have asserted, from the Foxes. The wild Canidae are hyperopic or emmetropic and free of marked astigmatism, while the domestic Dog often exhibits myopic or compound myopic astigmatism.

In the fundus oculi of the *Common Jackal* (Canis aureus) the central *tapetum lucidum* is of a golden color and very large. The intermediate green area is correspondingly small and bordered externally by a narrow violet zone which runs

into the deep purple peripheral zone. The disc is bright pink and lozenge shaped—a form peculiar to the Foxes and Jackals. The central vessels are numerous and stretch well to the periphery.

Carnivora, Fissipedia, Procyonidae. The fundus of the *American Racoon* (Procyon lotor) has points of resemblance to both the Polecats and Bears. In all three genera we notice the fundus pigment arranged in a crystalline fashion. The pale, golden-yellow zone has a number of rice shaped, yellowish dots scattered over it. The peripheral zone is partly brown in color.

The Bears.

Carnivora, Fissipedia, Ursidae. Nearly all the Bears have round pupils. In the *American Black Bear* (Ursus americanus) they are vertically oval; round, when fully dilated. They all have *membranae nictitantes*, which show only when the animal is sleepy. The ocular fundus is about the same in each species and closely resembles that of the Racoon. In our Black Bear the yellow zone is absent, but orange pigment is distributed between it and the peripheral zone. The latter is deep brown, as in the Racoon. The disc is round and cupped; the fundus pigment has a patchy, crystalline appearance, like coarse sugar scattered over the background.

Hoofed Animals.

The eyes of the important family of the *Ungulata*, Johnson finds to be divisible, so far as the fundus appearances go, into two great classes. The cloven hoofed (Artiodactyla)—ox, sheep, deer, camel, pig, etc.—have numerous large retinal capillaries; while others—horse, rhinoceros, elephant, zebra, etc.—have either very fine papillary vessels or present discs entirely devoid of visible blood supply. The Elephant, Tapir and Rhinoceros have circular pupils; in all the other Ungulates they are horizontally oval. The pupils are insensitive to mydriatics but contract well to light. (Fig. 2).

The irides, as a rule, are composed of two distinct layers, the inner stratum being capable of projection into the pupillary space, in much the same manner as an awning is let down in front of a shop window and for the same purpose.

This *corpus nigrum*, or shield to the sensitive retina from the glare of the sun, is fairly well seen in the domestic Horse and Goat. The best examples occur in the Hyrax, the Camel and the Llama, where it is developed into a special organ, and to it Johnson gives a particular name — *umbraculum*. In the Horse we see it as a simple hypertrophy of the lower pigment layer of the iris. It is somewhat thicker and larger in the Wild Ass, modulated in the Gazelle and Goat, and further elaborated in the Camel and Llama, forming in the

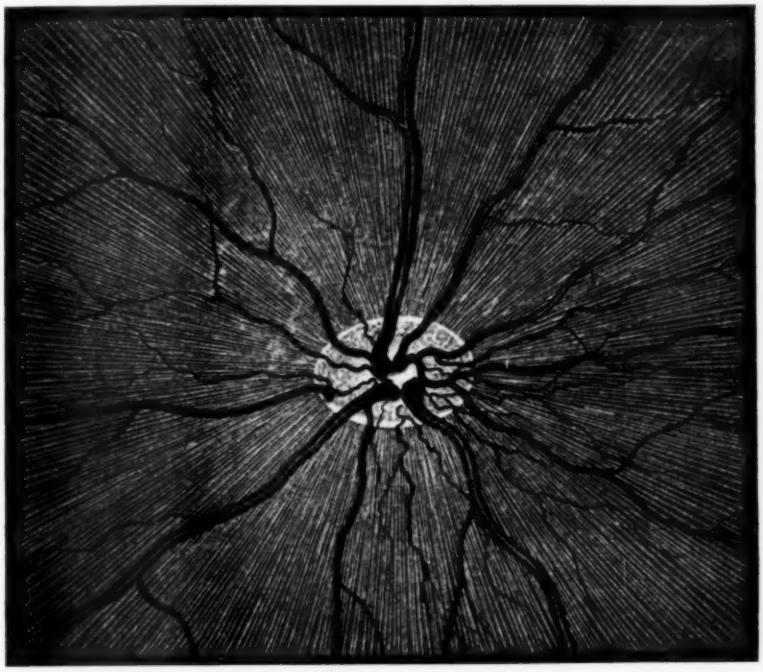

Fig. 2. Fundus of the Wild Boar. [Lindsay Johnson Atlas.]

latter a series of dentate projections that fit into one another when the pupil is fully contracted. In the Cape Hyrax or Klip-dass (an interesting animal that resembles in habits and appearance a Guinea Pig) we have the most highly developed of these appendages. Johnson believes it to be under the control of the will, as its movements are independent of the amount of light.

The refraction of the Ungulata is invariably a compound hypermetropic astigmatism. They have nearly all more or less well developed *tapeta lucida*.

THE RUMINANTS.

Ungulata, Artiodactyla, Ruminantia. The fundus of the *Indian Ox* (Bos indicus) is like that of our domestic cow, and indeed resembles those of all the other Ruminants. The disc is horizontally oval and very large, with a central circular depression. The main artery and vein, of large size, spring from the sides of this cup and ascend, giving off, at right angles, branches to the central light colored area. Downwards to the dark peripheral zone run numerous and more tortuous vessels, while the intermediate rose-colored band seems free of vascular supply. Lindsay Johnson believes this middle zone to be the seat of acute vision.

Bactrian Camel (Camelus bactrianus). This is another remarkable fundus picture, evidently only a variant of the previous one. It is of a uniform chocolate-red (there being no *tapetum lucidum*), the larger part light in color because of the innumerable opaque nerve fibres. The disc is circular, white, and covered with a pigment network. The intertwined artery and vein ascend from the optic papilla, giving off both horizontal and oblique branches.

Ungulata, Perissodactyla, Equidae. The fundus of the Horse, Zebra, Wild Ass, American Tapir, Indian Rhinoceros, African Elephant and Dorsal Hyrax — all belonging to the genus Perissodactyla — are devoid of retinal vessels. The eyes of the first three may be described as one—that of the Zebra—so closely related is their whole ocular apparatus. The fundus of the *Zebra* (Zebra burchelli) is divided into two zones, a peripheral violet-brown zone, deeply pigmented and a central zone, lying immediately above the disc, stippled with purple-brown, star-shaped spots on a colored ground. In the Horse and Zebra the background is yellow-green; in the Wild Ass it is a mixture of yellow and bluish green. The disc is pink and oval; numerous minute capillaries are seen at the disc edge, but these can be traced for a short distance only. Opaque nerve fibres are also present. As frequently observed, domestication affects the coloration of the background; various horses have varied fundus coloring. All the Equidae have a well developed nictitating membrane which they use freely. The pigmented protrusion at the edge of the iris, or *corpus nigrum*, is more highly developed in the wild than in the tame animal.

Ungulata, Perissodactyla, Tapiridae. The *Brazilian Tapir* (Tapirius americanus) being a night animal, has a bright, golden-yellow fundus which is stippled with orange dots. The peripheral zone is orange-red. There are only a few minute retinal vessels, restricted to the edge of a chalky-white disc.

Ungulata, Perissodactyla, Rhinocerotidae. Every Rhinoceros has small, bright, twinkling eyes, the twinkling being due to a rapid, oblique movement of the globe outward and slightly upward, motions performed by the animal every few seconds. In this way the Rhinoceros is enabled to look around without the necessity of turning his massive and unwieldy head. The pupil, 9 mm. in diameter, is surrounded by a dark iris. There is well formed membrana nictitans. The fundus oculi of the *Indian Rhinoceros* (Rhinoceros unicornus)—an animal specially protected by dermal armor—is certainly primitive. There is little to be seen except a large, white, round disc in the center of a violet-brown field which is covered with a faint network of pigment.

Ungulata, Proboscidae, Elephantidae. The *Elephant*, both Indian and African, has a yellow-ochre fundus with bacillus-like markings which are more prominent in the older animals. The disc is round and grayish-white. A few small capillaries run from the central cup to the margin of the discs. The pupil of the Elephant is circular and he has a well marked membrana nictitans but makes little use of it.

Ungulata, Hyracoidae. The most peculiar part of the ocular apparatus of *Hyrax* (Hyrax dorsalis) is his well developed *corpus nigrum.* As we already know, it is a highly contractile, awning-like appendage formed by an extension of the upper margin of the iris. Upon exposure of the eyes to bright sunlight it projects downward and forward to the posterior surface of the cornea. The fundus pictures of all the Hyracoidae are almost indentical and somewhat resemble the Elephant. The faintly stippled, reddish-brown background shows a few traces of choroidal vessels. The disc is pinkish and has a few oddly disposed vessels running from its center. Opaque nerve fibres, symmetrically disposed, radiate several diameters from the papillary border.

The Rodents.

The Rodentia have all circular or nearly circular pupils under all conditions of expansion or contraction. The wild animals invariably exhibit hyperopia which tends toward myopia and astigmatism in captivity. Thus domestic Rabbits show all degrees of refraction with astigmatism, while the common wild Hare is markedly hypermetropic. All rodents have the power of retracting the eye into the orbit, the lid closing as the organ is withdrawn into its socket. The nictitating membrane is rudimentary and the cornea is nearly a perfect hemisphere. The crystalline lens in the majority seems to be formed of concentric circles, which make it difficult to examine the fundus details.

Rodentia, Myomorpha, Muridae. The fundus of the *Black Rat* (Mus rattus) is uniformly gray in color. The White Rat, by the way, has the usual bleached background of the albino. No trace of choroidal vessels can be seen. The disc is reduced to a mere point, obscured by the large central vessels, which radiate from the center like the arms of a starfish. Johnson has examined anatomically the optic nerve of these animals and says it is no larger than a cotton thread. Faint opaque nerve fibres are also to be seen in this fundus.

Rodentia, Sciuromorpha, Sciuridae. The Squirrel has a more varied and more curious ocular fundus than that found in any other genus. This fact inclines Johnson to the belief that in it have been included members that properly belong to other zoological households. The *Common Squirrel* (Sciurus vulgaris) shows a wonderfully large nerve-head for such a small eye. It is much elongated, irregularly bow-shaped and placed well above the axis of vision. The whole area of this papilla measures four times that of the Elephant. The ends are distinctly clubbed. The retinal vessels are large as well as numerous, and spring from the margins of the disc in parallel lines. The disc is whitish and depressed below the fundus so that the vessels curl over its edge. Innumerable minute nerve fibres, arranged like the teeth of a fine comb, run from the disc edge. As Johnson says, the whole arrangements reminds one of a centipede. The fundus coloring is pale pink, the retinal arteries cannot be distinguished from

veins, and towards the periphery the choroidal vessels are visible.

Rodentia, Sciuromorpha, Castoridae. The Beavers have an ocular fundus all their own. In the *Canadian Beaver* (Castor canadensis) the disc is circular and white, with a deeply pigmented elevation at its center. About this organ (probably a hyaloid remant which projects several millimetres into the vitreous) a few minute capillaries may be seen. Otherwise there are no visible retinal vessels. The fundus is pale brown and covered with a network of choroidal capillaries. There are no opaque nerve fibres. It may be added that the Chinchilla has an almost identical fundus, except that there is no central projection from the disc.

Rodentia, Hystricomorpha, Cavidae. The fundus of the Hystricomorpha—chinchilla, guinea pig, agouti, porcupine, etc.—exhibits no retinal vessels, but generally a number of fine capillaries can be seen on the edge of the disc. In most of these animals a pecten-like protuberance, consisting of pigment cells and blood vessels can be seen extending from the center of the disc into the vitreous. The *Guinea Pig* (Cavia porcellus) has a fundus something like that of the Beaver except that there is a well marked "sunburst" of opaque nerve fibres with the papilla for its center. As has been noticed, variations occur—even in this primitive eye—under the influence of domestication.

Rodentia, Hystricomorpha, Cavidae. The Porcupines—as in the case of the Rhinoceros, Armadillo and other animals especially protected by nature from external injury—have exceedingly primitive eyes. The *Brazilian Porcupine* (Sphingurus prehensilis) has a vermillion fundus with orange streaks, probably corresponding to large, concealed choroidal vessels. No retinal vessels can be seen. There is no distinct peripheral area, while the round disc is bluish-gray and devoid of visible blood supply.

Rodentia, Logomorpha, Leporidae. The *Domestic Rabbit* (Lepus cuniculus) has a vermillion-red fundus; the wild Hare a lake-colored background; otherwise these remarkable pictures are identical. An ovoid white disc is seen, well above the visual axis, from which retinal vessels branch right and left in a horizontal plane. The area they

occupy is covered by a large dense "brush" of completely opaque nerve fibres, arranged like two white horse-tails, or like two ostrich feathers joined at their quills. As the vessels and opaque fibres are confined to one portion of the fundus, vision is not interfered with except in this locality. (Fig. 3).

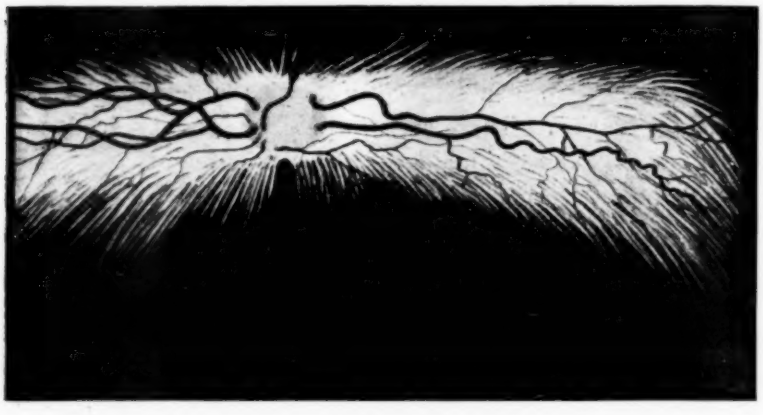

Fig. 3. Fundus of the Common Rabbit. [Lindsay Johnson Atlas.]

EDENTATA.

The eyes of this family are very sensitive to light, and consequently difficult to examine with the ophthalmoscope. The pupil is very small but dilates easily under atropia. As in the Bears, they possess the power of retracting the globe well within the orbit. The fundus is that of a rudimentary visual organ. The background is slightly stippled but is otherwise of a uniform color.

Edentata, Dasypodidae. The *Hairy Armadillo* (Dasypus villosus) exhibits a typical edentate fundus. It is of a uniform reddish-brown with a large, round, chalk-white disc showing no trace of blood vessels. The papilla is situated above the visual axis; altogether a primitive eye, such as one would expect to find in an animal depending upon armor, or at least not dependent upon his eyesight for food or protection. He has well formed eyelids and winks every few seconds, the eyeball receding each time, while the lids bend inwards toward the apex of the orbit instead of sliding over the globe as they do in man. There is no membrana nictitans.

Marsupialia.

In conclusion, we reach the Marsupials. This family—the "odds and ends" of the Mammals—has almost every one primitive eyes. Many exhibit the pecten, as a reminder of their reptilian (or rather sauropsidian) ancestry, and few of them have retinal vessels. All possess circular pupils and an active membrana nictitans.

Marsupialia, Diprotodontia, Mancropodae. The *Kangaroo Rat* (Hypsiprymnus rufescens) has a brownish fundus, with few retinal vessels, but numerous prominent choroidal vessels. The latter are large and of uniform size.

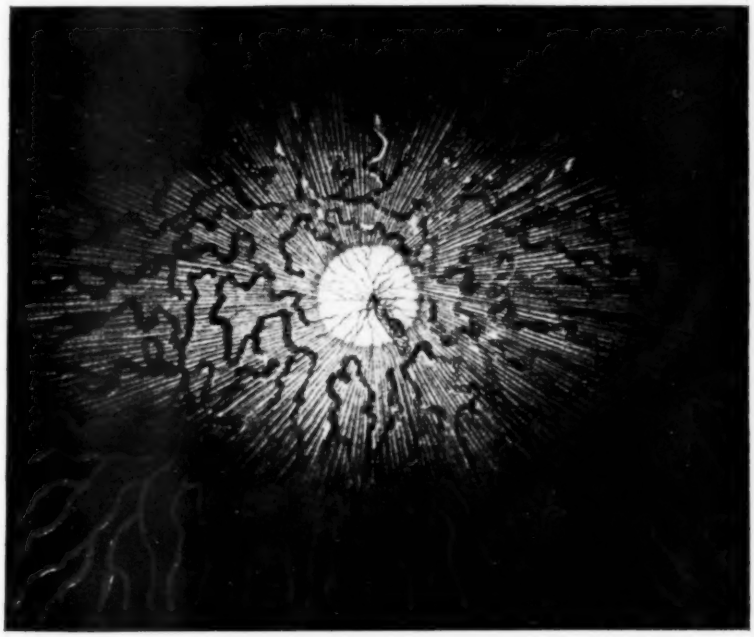

Fig. 4. Fundus of the Rat Kangaroo. [Lindsay Johnson Atlas.]

They ramify throughout the background of the eye and anastomose around the papilla. The disc is yellow white, covered with minute capillaries and presents a sausage-like projection from its center into the vitreous. The latter formation is mostly made up of festoons of vessels derived from the central artery of the retina. (Fig. 4).

Marsupialia, Polyprotodontia, Didelphidae. Our own particular Marsupial, the *Virginia Opossum* (Didelphys virginiana), differs ophthalmoscopically from other members of his family. The Tasmanian Devil and he are the only members of it with retinal vessels. As he is a nocturnal animal also, he has a well developed tapetum lucidum. The Opossum has another peculiarity: although devoid of a true nictitating membrane, two folds of conjunctival tissue arise from either canthus, meet in the meridian line, cover up the eye entirely in a sort of loose double bag and when function-

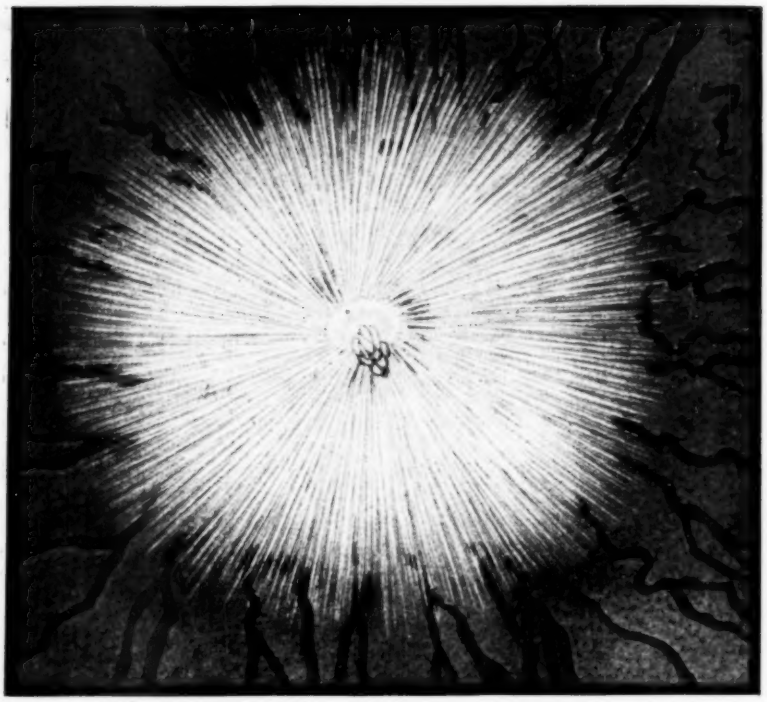

Fig. 5. Fundus of the Rabbit-eared Perameles. [Lindsay Johnson Atlas].

ating force the eye back into the orbit. When this organ is in use the animal looks as if he had projecting from his cornea a large edematous tumor. The central zone of the ocular background is of a brilliant golden-yellow, surrounded by a peripheral zone of grayish-black, with interspaces through which the golden-yellow color shines. It has a gray disc, with well developed and equally radiant vessels.

Marsupialia, Polyprotontia, Peramelidae. The Bandicootes, have remarkable backgrounds. The *Rabbit-eared Perameles* (Perameles lagotis), another curious Marsupial, exhibits a wonderful arrangement of concentric opaque nerve fibres about the disc, extending to the periphery and making a figure like a white China aster. A pectinate remnant covered with minute vessels and fashioned like a miniature wicker basket occupies the center of a gray-white ovoid papilla. Unusually large choroidal vessels ramify throughout the fundus. (Fig. 5).

Monotremata. The *Echidna* or *Spiny Ant-eater* (Tachyglossus aculeatus) of New South Wales has a circular pupil, no membrana nictitans, and a fundus of the most primitive type, all corresponding to his doubtful position in the Mammalian world. Like other Marsupials, he is able to retract his eyeballs. The background is of a lavender color throughout, the papilla being large, chalk-white and vertically oval. Neither retinal nor choroidal vessels are to be seen. Faintly outlined, short-ray, nerve fibres surround the optic disc.

Conclusions.

From a study of the eyes of the Mammals and particularly from the observations made by Lindsay Johnson on the appearances of the ocular fundi, I believe we are justified in drawing the following conclusions:

First—The fundus appearances of the normal Mammalian eye are practically identical in wild individuals of the same species.

Second—Common features in the ophthalmoscopic picture are strikingly apparent in the members of the same genus, and even of the same family.

Third—As a consequence of the foregoing, the importance of using the ophthalmoscope in the classification of animals possessing eyes whose fundi can be seen is of great importance.

Fourth—A complete account of any animal in a systematic treatise on zoology should include, when it is possible, at least a brief description of the ocular fundus. In other words, the practical zoologist should be able to use the ophthalmoscope.

Fifth—Apart from disease, the principal cause of the variations in the color and other details of the fundus oculi of species is domestication.

Sixth—Doubtless the habits and environment of the animal have been the chief factors in determining the coloration and other features of his eyegrounds.

Seventh—Ophthalmoscopic studies of the eyes of the lower animals throw considerable light on the anatomy, physiology and embryology of the human eye.

Eighth—An examination of the eye-interiors of representative species proves that some of the conditions observable in certain animals have their analogues in man as acquired disease, as congenital defects, and as ancestral remains.

JUVENILE GLAUCOMA SIMPLEX ASSOCIATED WITH MYASTHENIA GASTRICA ET INTESTINALIS.

By JOHN GREEN, Jr., M.D.,
ST. LOUIS. MO.

THE train of events leading to the establishment of the glaucomatous state is often difficult to trace. If this statement be true of acute and chronic congestive glaucoma, it is doubly so of glaucoma simplex. Indeed, the problem of the ultimate origin of the latter has seemed to certain acute observers so radically different from the problem of the etiology of acute and chronic congestive glaucoma, that they have not hesitated to remove glaucoma simplex from the category of the glaucomas, preferring to regard it as a progressive optic nerve atrophy with excavation of the nerve head. According to this view the initial process is an optic neuritis which leads to blocking of the lymphatic channels in the nerve sheath; as a consequence, the removal of the products of metabolism is hindered or prevented. "Hence the rise of tension and excavation, i. e., the production of what has been called *posterior glaucoma*." (de Schweinitz).

Assuming that this theory is correct, it becomes of the utmost importance to determine, in every case of glaucoma simplex, whether there may not be present a concomitant constitutional vice which might conceivably have given rise

to optic neuritis. The important rôle of certain general infections (syphilis, rheumatism, influenza, etc.) in the etiology of optic neuritis can no longer be denied, nor can it be asserted that the future will not disclose other constitutional causes at present unsuspected. The majority of such cases do not, of course, eventuate in glaucoma. For such cases as do terminate in the so-called glaucomatous excavation of the nerve head, it seems necessary to assume in addition a special vulnerability of the ocular tissues to the toxic agent.

The subjoined case seems worthy of record, first, because of the rarity of juvenile glaucoma, and second, because it offers some support to the conception of a constitutional origin for the disease.

Miss A. A., aged 30, a tall, spare, sallow woman, came under observation July 7th, 1904. The family ocular history was negative. The personal ocular history was as follows: When fifteen years of age the patient accidentally discovered that she could not tell time on the school room clock with the left eye. The sight grew progressively worse, and six years ago the eye became totally blind. From the age of fifteen to eighteen she attempted to study music, but was compelled to relinquish this pursuit as well as to cease using the eyes for any purpose whatever on account of ocular aching. On two different occasions during the past eight years she has obtained glasses which failed to relieve the symptoms. The eyes have never been inflamed or severely painful.

At present she is entirely unable to use her eyes, the print wavering and blurring almost as soon as she directs the gaze upon the paper. The eyeballs feel tense and ache. There is a sense of pressure in the orbits. Latterly she has had much occipital pain.

Ocular examination: The left eye diverges about 15°. The globes are free from congestion, except that the anterior perforating veins in the left eye are somewhat enlarged. The right pupil is 3.5 mm. in diameter, circular and reacts well to light and convergence. Left pupil is slightly larger and fixed. The anterior chambers are of normal depth. Left cornea is anæsthetic. R.E. T+? L.E. T+1. R.E. V.$^{16}/_{19}$. L.E. V. faint p.l. Ophthalmometer: R.E. As 1. Mc 15°; L.E. As 3. Mc 165°.

Ophthalmoscope: R.E. Media clear; optic disc of a whitish grey and the seat of a steep glaucomatous cup measuring 8 D. The nerve head is surrounded by a well marked scleral ring. Arterial pulsation at the disc can readily be elicited by gentle massage of the globe. L.E. presents quite similar appearances, except that the disc is excavated to a depth of 12 D.

The visual field for white determines a moderate inferonasal contraction. A diligent search failed to reveal partial scotomata or sector defects within the limits of the field. Color vision normal. No central scotomata either for form or color. Diagnosis: glaucoma simplex, both.

A single small drop of eserine sulphate ⅓ of 1 per cent. produced marked but not excessive miosis. The patient was instructed to use a drop of an aqueous solution of pilocarpine muriate ½ of 1 per cent., three times a day. It was noted that the miosis resulting from each instillation lasted about two and a half hours. The sole effect of this treatment was to lessen the ocular discomfort and partially relieve the occipital pain. There was no effect on the field of vision. Before leaving for home the patient was provided with spectacles for constant wear—R.E.+.75 cyl. ax. 15°; L.E. 0.

One month later the patient returned and stated that she had been practically free from ocular discomfort but was entirely unable to use the eyes on account of the immediate appearance of a blur over the print. R.E. V.$^{16}/_{24}$. Alteration in the strength and axis of the cylinder did not improve vision. Visual field unchanged. Pilocarpine solution was supplemented by a $^{1}/_{5}$ of 1 per cent. solution of the alkaloid of eserine in castor oil, which was used once a day. As the latter drug in this strength produced ocular pain lasting several hours, I substituted a weaker, oily solution—$^{1}/_{10}$ of 1 per cent.—which proved equally effective as a miotic and did not evoke any ocular discomfort.

In October, 1904, it was found that the field on the temporal side had shrunk a little.

In December, 1904, the field was the same as in October, but central V. had gone off to $^{16}/_{30}$. On attempting to read a magazine the words "danced and wavered" and the eyes pained.

Up to this point the course of the disease certainly did not augur well for the future. There had been a slow but steady loss of central vision and a gradual drawing in of the temporal field. I suggested to the patient the possible necessity of an iridectomy, explaining the immediate and remote hazards of such a procedure.

With a view of obtaining as much collateral information as possible, inquiry was made into the patient's general medical history. She had never considered herself strong, but had never suffered any prolonged illness. She admitted, however, being habitually constipated, which condition had persisted since early childhood. Numerous drugs had been tried with only temporary relief. The patient was referred to Dr. Jesse Myer, who elicited the following additional points: The father died of stomach trouble, presumably cancer, and the mother of "locked bowels." For the past nine years the patient has had stomach trouble characterized by pain in the epigastrium and belching. She has never vomited or passed blood.

The chief complaint is of constipation. Appetite is good and there has been no loss of weight. The patient can eat practically everything she cares to without suffering distress. The physical examination determined a floating tenth rib, intermittent and weak heart sounds—dropping every sixth beat. There was pain on pressure in the left hypochondrium and posteriorly over the eleventh dorsal vertebra. Stomach displaced downward. Urine showed a trace of albumin (no casts). Diagnosis: myasthenia gastrica et intestinalis, probably congenital.

The patient underwent a course of dietary and electrical treatment with abdominal massage for two weeks early in January. Improvement in the abdominal symptoms was immediate. On January 17th the patient volunteered the statement that "the treatment for the constipation had helped the eyes a great deal." It appeared that she was whiling away the tedious hours at the hotel by reading novels, and was gratified to find that each successive day gave her additional ability to use the eyes. She was now able to read continuously for ninety minutes without any sense of strain or blurring of the letters. This statement was confirmed by a reading test in my office extending over a period of two

hours. R.E. V. had risen to $^{16}/_{19}$, the recognition of the letters being quick and unhesitating. No enlargement of the field. She was permitted to return to her home with instructions as to the continuance of the constitutional treatment. The pilocarpine and eserine drops were continued.

June 6th, 1905, the improvement in the general condition has been maintained, the patient having a daily movement from the bowels. R.E. V.$^{16}/_{15}$. The field has again widened on the temporal side. Treatment continued.

August 16th, 1905, still able to use the eyes freely. R.E. V.$^{16}/_{12}$, quick recognition. Field as on June 6th. Patient was cautioned against excessive use of the eyes.

To summarise: A young woman free from hereditary ocular taint and afflicted with a chronic constipation beginning in earliest childhood, is attacked with glaucoma simplex shortly after puberty. In one eye the failure of vision is progressive and results in blindness. Near work is found to be out of the question on account of ocular pain and blurring. Finally, the vision of the fellow eye beginning to fail, she seeks relief.

Treatment with miotics over a period of several months fails to check the progress of the disease. General treatment directed against the constipation is instituted. Improvement in the general condition is accompanied by a like amelioration in the vision, in the ability to use the eyes, and later by a widening of the visual field.

Although inferences drawn from the study of a single case are generally of little value, the sequence of pathologic events in this patient seems to justify the tentative assumption that the gastric and intestinal myasthenia really constituted the *fons et origo mali*. It is well known that in cases of chronic constipation resorption of noxious material from the intestine—copraemia—takes place to a limited extent. It seems perfectly reasonable to assume that such a toxic agent might have given rise to an optic neuritis. If, then, we suppose an inherent weakness in the lamina cribrosa, the chain of events leading to the excavation of the nerve head is complete. Confirmatory evidence is furnished by the notable improvement in the ocular condition immediately following the re-establishment of normal intestinal function.